DOCUMENT RESUME

ED 119 669 IR 003 132

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TITLE Broadcast Evaluation Report Number Three: Instrumentation, T291: TV6.
INSTITUTION Open Univ., Walton, Bletchley, Bucks (England). Inst. of Educational Technology.
PUB DATE Feb 75
NOTE 42p.; Audio-Visual Media Research Group

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage
DESCRIPTORS *Course Evaluation; Educational Alternatives; *Educational Television; Electronic Control; *Electronics; External Degree Programs; Higher Education; Instructional Media; *Instrumentation; Student Attitudes; Technical Education
IDENTIFIERS *Fourier Analysis; Great Britain; Open University; Transducer Response

ABSTRACT

A course in instrumentation offered through the British Open University included a television program which introduced and illustrated Fourier analysis and transducer response. The television component was evaluated using questionnaires, telephone interviews, and group discussions. The program was successful in that it demonstrated complicated operations which would be costly to provide by laboratory sessions and impossible to provide through home experiment kits. Some problems were encountered by students in relating Fourier synthesis and analysis to tranducer response as presented by the television program. Other difficulties were encountered with program transmission schedules and distribution of textual materials to students. Students generally reacted favorably to the broadcast itself but felt that the broadcast notes were inadequate. (CH)

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ED119669

Broadcast Evaluation Report No. 3

"INSTRUMENTATION"

T291 : TV6

Audio-Visual Media Research Group
INSTITUTE OF EDUCATIONAL TECHNOLOGY
Open University

R 083 132

Broadcast Evaluation Report

No. 3

Television Programme 6: "Fourier analysis and transducer response".

Related to Units 8, 9 and 10: "Transducers 2: Acceleration, Vibration, Velocity, Flow".

Open University Course T291: "Instrumentation".

Evaluator Tony Bates, Senior Lecturer, Institute of Educational Technology.

Producer Tony Jolly, BBC.

Academics Gaby Smol, Senior Lecturer, Technology.

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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CONTENTS

		Page
The 1974 broadcast evaluation programme		
	Aims and Criteria	1
	Evidence	3
	Method	4
The television programme in context		
	The course and relevant units	11
	The television programme	12
	The broadcast notes and supplementary material	16
	The timing of the programme	17
Evaluation of the television programme		
	Method	20
	Results: viewing and listening figures	22
	student reactions to TV6	26
	broadcast notes and reaction to television as a whole	29
	Discussion	31
Summary and recommendations		
	Summary	34
	Recommendations	35
	References	37

Appendices

A. Course calendar
B. Letter to students and postal questionnaire
C. Student responses to open-ended questions
D. Transcript of group discussion
E. Course tutor comments
F. CMA 45 feedback

(The appendices are bound separately, and are available on request from Audio-Visual Media Research Group.)

THE 1974 BROADCAST EVALUATION PROGRAMME

Aims

This report is one of a series of 18, based on evaluations of 35 Open University programmes carried out during 1974, by the Audio-Visual Media Research Group of the Institute of Educational Technology, in conjunction with the BBC.

What we are trying to do in these studies can be summarised as follows:

1. to discover typical or potential uses of broadcasting within a faculty area, to see whether these succeed, and whether improvements are needed, with the idea of generating information useful for decision-making in new courses likely to use broadcasting in a similar way.
2. to provide producers with information about certain issues which arose during the making of a specific programme - for example, did students find a particular technique helpful or not?
3. to discover practical difficulties encountered by students in using broadcast material (e.g. awkward transmission times, late mailing of related printed material, etc.), and possible ways of overcoming these difficulties.
4. to produce information which will generate and test some assumptions made by the Audio-Visual Media Research Group about the uses of broadcasting in the Open University, and how students use or learn from broadcasts. Some of the questions to which we are seeking answers are:
   (i) to what extent do students benefit or suffer as a result of the position of a broadcast in a course?
   (ii) do students require more help in identifying the function of broadcasts and how to use them in their studies than is currently accepted in course production?
   (iii) do course teams make the fullest use of the potential of broadcasting in the Open Univeraity situation?
5. to involve producers and academics in a detailed evaluation study, with the aim of demonstrating some of the evaluation methods available, and how to select and use these methods, so that producers are more aware of what they might do themselves, and of the limitations and difficulties of certain approaches to evaluation.

Criteria

It can be seen that the emphasis in the studies is on the improvement of broadcasting as a teaching device. We are more concerned with learning how to make future programmes more helpful for students, than with passing summary judgements on individual programmes, or on broadcasting as a whole. On the

other hand, it would be misleading for us to pretend that the evaluation reports were totally objective, and unsullied by the values held by the evaluators themselves, or by the producers and academics involved in the studies. For improvements to be suggested, some model, however vague, is necessary of what broadcasting ought to be doing in the Open University. For this reason, we will try to make explicit what criteria we have had in mind when we have been studying programmes.

First of all, we have been concerned to examine whether the broadcasts have been made with a clear educational intent, in the sense of providing the student with knowledge or experience relevant to the course he or she is pursuing. This is an important point, and it is crucial to the likely acceptance of the evaluation reports that our intentions here are fully understood. Certainly we have in general tried to avoid judging whether the educational aims of the programme were the right ones, at this stage of our enquiries. Whether a particular way of using television or radio is appropriate in the Open University situation cannot be determined by evaluation of a single programme. A programme may fail for many reasons, none of which may be connected with the educational intentions underlying the programme, or with the way it was made. It is hoped, though, that as we increase the number of programmes evaluated, it will become clear that certain kinds of intention behind a programme will be very difficult to achieve, that others require certain pre-requisites or conditions, while yet more can usually be achieved with ease in the Open University situation. In other words, we have tried to avoid commenting on whether a programme should or should not have chosen, as a matter of principle, for example a case study approach, or a particular topic as a case-study, at a certain point in time. What we have been concerned with, though, is whether there was at least some kind of educational purpose behind the choice of the material or approach, and whether in fact the students were able to discern this purpose, and use the material provided in a relevant way (even if the way the material was used was unanticipated).

The question of whether a programme is relevant or not is much more complex. This is a judgement that we would prefer to leave to the course team. Nevertheless, the students' perception - rightly or wrongly - of a programme's relevance is of course crucial to the likelihood of the programme succeeding in its intentions, and this has been an important part of our enquiries. In general, though, we have proceeded on the assumptions that the course team at least believes the programme has relevance to a course.

Another criterion generally present in our evaluation of particular television programmes has been whether the programme has been able to provide students with knowledge or experience which it would be difficult to provide as cheaply or conveniently in any other way in the Open University situation. It is not a criterion we would wish to apply mechanically, without other considerations being taken into account. There is considerable virtue in providing students with a variety of programme formats, and under certain circumstances we recognise it will be more convenient or appropriate to use

television, when radio or print could well have been used instead. Nevertheless, television is a scarce resource within the University, and therefore we believe that our evaluation should concern itself to some extent with the potential of broadcasting for uniquely bringing certain knowledge and experiences to the student.

A third criterion we have borne in mind is the extent to which the intended relationship between broadcast and text has been achieved, and the extent to which students have been able to integrate broadcasts with the rest of their activities. Occasionally, of course, programmes are deliberately designed to stand alone, but nevertheless there is usually some assumed relationship between broadcasts and texts, and so we have been concerned to discover whether students themselves have been able to make this integration.

When preparing these evaluation reports, we have tried to avoid incorporating in the reports our own judgements on the artistic or aesthetic quality of a programme. This is not because we have been uninfluenced by such factors, nor because we believe them to be unimportant. However, although we have very clear preferences for some programmes over others, which may well show through in some of the evaluation reports, our views on this aspect of a programme are not likely to be better based than anyone else's. Furthermore, we believe that it would be very difficult to draw conclusions for future programme-making as a result of an interpretation of the aesthetic quality of a programme. There are, as will become apparent from the evaluation reports, enough mundane matters which need to be altered or improved, without our having to enter this difficult area. Similarly, we have not generally been too concerned with techniques of programme-making, except where we have been asked specifically by a producer or academic to investigate whether certain techniques have enhanced or impeded the educational aims of a programme, or where it has become clear from student responses that problems have arisen as a result of techniques used in the programme. The emphasis of the evaluation therefore is intended to be very much directed towards the educational aspects of the broadcasts.

Evidence

Besides trying to make explicit the criteria which have guided us in these studies, we ought also to clarify the relative importance we have given to various kinds of evidence. For instance, although obviously a programme stands a much better chance of achieving its objectives if it is rated highly by students, in terms of usefulness, interest, enjoyment, etc., we have not been content to accept this as a main criterion, for a number of reasons. It will become clear on reading our studies that students or even tutors are not always the best judges of the relevance or even the intellectual weight of a programme. Furthermore, students vary in their reaction to different programmes, and frankly we are more interested in discovering why a programme helps one group of students and not another.

Nor have we put heavy reliance on the more classical type of evaluation evidence, that derived from performance tests. The main aim of a programme is seldom to introduce important and fresh cognitive content. If the ideas are that important, they are nearly always dealt with in the correspondence texts as well. Therefore it is often impossible to deduce from performance tests alone what a student has learned from the broadcast, and what he has learned through the correspondence text. In addition, performance tests rarely indicate what corrective action is necessary to improve a programme. There are often other important aims behind a programme which are not strictly content-based, and many of the reasons why programmes do not succeed as well as they might have nothing to do with the actual content of the programmes. Performance testing therefore is, on its own, too narrow a base for evaluation, but nevertheless it still has a useful role in our studies, used in conjunction with other evidence.

Group discussions can be extremely useful for generating ideas about why programmes have succeeded or failed, and what kind of improvements could be made. However, a group discussion can also be very untypical of the general student reaction to a programme. The initial reaction of the first student to respond to the programme tends to set the tone for the rest of the group. Furthermore, students usually watch in isolation, rather than in groups, and the group situation stimulates students to think about a programme in a different way to that of the isolated student.

Evidence from the standard University feedback sources, such as CURF (the Course Unit Report Form), CT4 (Course Tutor Reports), and Staff Tutor reports, is sometimes lacking for a specific programme, and when it does exist, is usually not detailed enough. Furthermore, both CURF and CT4 suffer from low response rates, and so one is never sure whether the information is representative.

Finally, even specially designed questionnaires, based on a representative sample, and with high response rates, suffer from the superficiality of response to the questions set. Telephone interviewing can sometimes overcome this, but 40% of our students do not have telephones.

It can be seen therefore that every source of evidence, taken alone, has its drawbacks. We have therefore tried to create a situation where information from a wide variety of sources has been collected, so that with the relevant producer and academic we can build up a coherent picture of the way a programme has been used by students, the relationship of the programme to the rest of the course, the consequences for different kinds of student, and ways in which the programme could be made of more benefit to students.

Method

To do this, we have developed a method which we have used fairly consistently in nearly all the 18 studies, and which we hope to continue to use in 1975.

We invited in late 1973 senior producers in each of the six faculty areas to suggest between three and five programmes each, which were examples of typical or potential uses of broadcasting within a faculty area. Each senior producer

responded, and when the offers were examined in detail, it became clear that in some cases two or more programmes were linked together, and could be examined within one study. In effect, we were offered altogether 21 television programmes and six radio programmes. One television programme was not evaluated, as we were given the wrong programme number, and another programme was not evaluated because of pressure of work. In addition, we were also involved in a separate study of M231 (Analysis) which includes an evaluation of a further six television and four radio programmes (Ahrens, Burt and Gallagher, 1974). Thus the following programmes were included in the 1974 evaluation programme:

TABLE 1. Programmes evaluated in 1974

Evaluation Report No.	Faculty	Course	Television programmes	Radio programmes	Evaluators
15	Arts	A302	TV9	-	Gallagher
18		AMST283	TV8	-	Bates
6	Social	DS261	TV4	-	Gallagher
7	Sciences	DS261	TV6	Radio 9	Bates/Roberts
11		DT201	TV7	-	Gallagher
2	Educational	E221	TV3	Radio 6	Gallagher
8	Studies	E221	-	Radio 15	Gallagher
17		E283	TV6/7/8	-	Gallagher
10		E351	TV4/5/6	Radio 7	Bates
1	Mathematics	M231	TV1/2/3/4/5/6	Radio 1/2/3/4	Gallagher
12		MDT241	-	Radio 4	Gallagher
4	Science	S24-	TV7	Radio 3	Gallagher
9		S323	TV9	-	Gallagher
16		SM351	TV7	-	Gallagher
5	Technology	T100	TV26	-	Gallagher/Roberts
13		T241	TV11	-	Bates
14		T241	TV12	-	Bates
3		T291	TV6	-	Bates
18		15	25	10	

The way the sample of programmes was drawn requires justification. This was the first time that a detailed evaluation of a series of programmes had been attempted. (Two previous studies in 1972, one on E283, TV4/5 and Radio 9, and one on MST282, TV1-4 had been attempted, but at the express request of the producers involved). It was therefore necessary to ensure co-operation from the BBC. It was considered that the study would be more welcomed if the BBC itself was allowed to suggest the programmes to be evaluated. In any case, with over 800 television programmes and a similar number of radio programmes current in 1974, it was impossible either to choose a sample large enough to be representative of the whole BBC/OU output within the resources available, or for us ourselves to have a broad overview of the total production of programmes. We believe that the Senior Producer is in the best position to know the full range of output within his faculty area. Indeed, a major interest for us was to see what kind of programmes would be offered. In any case, it must be remembered that the aim of the evaluation is not to evaluate broadcasting as a whole, but to try to improve the use of broadcasting. If the programmes offered were therefore indeed representative of even just the future thinking of the producers in a given faculty area, this would be sufficient for our purpose. The danger of course is that programmes which are considered to be especially outstanding, or programmes where there is profound disagreement between producers and academics about their value, might be offered instead. Even should this have happened, though, there would be value in this. In effect, we were offered a very wide range of programme. Many without doubt were typical, while one or two were pointers to possible new developments in the use of broadcasting. The main weakness was the small number of radio programmes offered. Only two of the ten radio programmes were specifically offered, the remainder being dragged in through being linked to television programmes. This pattern in fact is being repeated in 1975. It is very difficult to obtain recommendations for radio programmes for evaluation, and this - together with some of the evaluation results - does suggest a serious undervaluing of radio, even in the BBC.

Once the sample had been settled, a work-plan for the year was worked out, to ensure a spread of work-load across the year. This led to programmes being allocated to each of us, six studies to Bates, and twelve to Gallagher. Between two and four weeks before the repeat transmission of a programme we would view the programmes on video tape, skim-read the text, supplementary material, and course guide, looking at the relationship between the text and programme, and then go and see the producer, and where possible the academic responsible. This interview was informal and unstructured, but the aim of it was to determine what the producer and academic were trying to do in the programme, what they would like us to find out, and any special difficulties which were encountered in getting the programme made, or difficulties anticipated when the programme was transmitted. Producer and academic were interviewed separately. These interviews and our examination of the broadcast and relevant printed material provided us with the basis for a questionnaire. Occasionally, where the subject matter was particularly difficult, the educational technologist attached

to the course team would provide help in explaining or suggesting difficulties, and in the wording of certain "test-type" questions. The draft of the questionnaire was then circulated to the producer and academic, for their further suggestions and approval, and to the University's Survey Research Department, for an independent view on the wording of questions. At the same time, the University Data Processing Division was asked to produce a random sample of generally about 200 students, with three sets of address labels, for postal questionnaires, and an independent random list of 50-100 students with telephones. This sample was drawn to avoid students on other studies (e.g. CURF). It was considered the minimum number necessary to give a reliable sample on each course (see the report itself for its error factor, as this varied from study to study.)

The questionnaires varied from study to study, but most contained questions about if or when the students watched or listened, reasons for missing the broadcast, (if they had missed it), whether they had read the unit and broadcast notes before or after seeing the programme, and where they were in the course, how useful, enjoyable, and difficult they found the programme, what they thought the purpose of the programme was, usually some questions about the content of the programme, sufficient to assess whether they had understood what the programme was about, and then questions specific to the programme being studied. Students were also usually asked how they were finding the course. A feature of all the questionnaires was the combination of pre-coded and open-ended questions. Students were asked, for instance, not only to rate the programme on a fixed scale of usefulness, but also to give reasons for their answer. The questionnaires were posted to arrive within five days of the second transmission of a programme. (Where two or more programmes were involved in a single study, the procedure varied, according to circumstances). A reminder was sent within 10 days, and a second reminder within another 10 days. These reminders boosted response rates considerably, most averaging over 70%.

On some studies (9 in all), the postal questionnaires were backed up by about 50 telephone interviews. These were used where there were doubts about whether a postal questionnaire would provide the information required in sufficient depth. The telephone interviews also proved useful as a general cross-check with questionnaire information. The interviews would be carried out over a period of five days in the evenings, by the whole evaluation team, sometimes supplemented by part-time - but trained - interviewers, and sometimes the producer was also used as an interviewer. In one instance, a group discussion was held with six students by telephone, using conference-call facilities. The decision whether to use telephone interviewing was also governed by the work-load in a particular week. Thus, on some enquries, although it was desirable, it was not practical.

Again on some studies (6 in all), group discussions were arranged, where the programme was shown to a group of students. The procedure was to contact a staff tutor and find out whether any classes or day-schools were arranged within a week of the transmissions. Sometimes a discussion could be specially

arranged. We would copy the programme from 1" Ampex on to ½" cassette, and take a VCR machine to the study centre, and show the programme to about 10-30 students. (Staff tutors had usually written to students to tell them we were coming, or even to invite them specially.) The discussion would be deliberately loosely-structured, led by the evaluator. Sometimes the producer attended, but was not always announced. The first question was usually: "What did you think of the programme?" The evaluator would normally have a range of questions prepared. In most cases, it was not necessary to put these questions, since they tended to be covered spontaneously in the discussion, but if the discussion began to drift away from the programme, one of these questions would be asked, in order to bring the discussion back to the programme. The discussion was sound recorded, and later transcribed. The aim of these discussions was to obtain ideas about the programme and what it meant to students, which we could not anticipate. Ideally, we would like to have based the postal questionnaire on the discussions, but these discussions had to be held after the transmission, and there was insufficient time to incorporate points from the discussions in the questionnaires. Used in conjunction with questionnaire, and other data, however, the discussions are useful for providing insight into student's ideas about broadcasting and how they use it. There is considerable evidence though from the evaluation reports that such discussions can give a very misleading impression of general student reaction, particularly if the producer is present. We also tried to hold group discussions at summer school for three of the studies, but these turned out to be either impossible to carry out (no-one turned up for two) or of no value for our purposes.

Finally, we have made use of other feedback information available, particularly course unit report form data, course tutor feedback from the CT4, and CMA feedback.

Pre-coded data from postal questionnaires and telephone interviews are hand-counted, and the open-ended comments are typed for each question. The quantitative and qualitative data are then sifted, and with manual cross-checks, a general picture is built up in the form of a full report. This report draws not only on information from this specific enquiry, but also on information from the other studies. This cumulative build-up of information is extremely important. For instance, a finding which looks none too solid in a single study - because, for example, it may be based on small numbers - becomes much more significant when the finding is repeated in several different independent studies. Similarly, a finding which has a number of possible explanations in one study can be more confidently explained in the light of similar findings in other studies. We have in fact waited until data from all 35 programmes have been collected before the first evaluation study has been written (with the exception of the M231 study.)

Nevertheless, it would be wrong to stress too heavily the level of certainty of our findings. We do not wish to give a pseudo-scientific gloss to our enquiries. It must be remembered that these 18 studies were carried out over a period of just six months (April to September 1974). The entire team

consisted of two evaluators, a research assistant (Carrie Roberts) a secretary shared with other IET staff, and a "spending" budget of £1500 for the whole year. In addition, the Group was involved in other major studies (e.g. piloting a VCR system in study centres) and heavy committee work. Nevertheless, a new study was being started almost every week during the six-month period. The actual combination of methods used was often just as much due to matters of expediency as to carefully designed research method. Nevertheless, we believe we were right to go for as many programmes as possible, and a wide variety of sources of information even if this has meant obtaining "quick and dirty" information. Table 2 summarises the sources of information available and used in each enquiry.

TABLE 2. Sources of Information Used on Each Enquiry

Evaluation Report No.	Programmes	Specially designed postal questionnaire	Telephone interviews	Group discussions	CURF	CMA (feedback)	CT4
15	A302/TV9	X	-	X	X	-	-
18	AMST283/TV8	X	-	-	X	-	X
6	DS261/TV4	X	X	-	X	-	X
7	DS261/TV6	X	X	X	X	-	X
11	DT201/TV7	X	X	X	X	-	-
2	E221/TV3/ Radio 6	X*	-	-	-	X	X
8	E221/Radio 15	X	-	X	-	X	X
17	E283/TV6 8	X	-	-	X	X	X
10	E351/TV4 6/ Radio 7	X	X	-	X	-	-
1	M231/TV1 6/ Radio 1 4	X	X	-	X	X	-
12	MDT241/Radio 4	X	X	-	X	-	X
4	S24-/TV7/ Radio 3	X	X	-	-	X	X
9	S323/TV9	X	-	X	-	X	-
16	SM351/TV7	X	X	-	-	-	-
5	T100/TV26	X	-	-	X	-	X
13	T241/TV11	X	-	-**	-	X	-
14	T241/TV12	X	-	-**	-	X	-
3	T291/TV6	X	-	X	-	X	X
18	18	18	8	6	10	9	10

* = questionnaire also sent to tutors

** = tried, but failed

At the same time, because we have been in a unique position of having studied a number of programmes across all faculty areas, we have risked interpretation and occasionally speculation. This explains why we have prepared such a full report, with as much information as possible available. We hope that the report is presented in such a way that the reader can draw his or her own conclusions about the validity of the results, and our interpretation of the results. In the long run, we believe that the real value, if any, of these reports will be in the stimulus and thought they provoke amongst those concerned with using broadcasting, rather than with the specific recommendations and conclusions. However, for those too busy to work through the full report, we have made recommendations and conclusions, and produced these in the summary.

Finally, just as important for us as the results themselves has been the co-operation that has resulted between producers, academics, students and ourselves. These evaluation studies have been, without exception, supported in every possible way by BBC producers, students and OU academics. Frankly, we underestimated both the amount of work involved for ourselves, and the willingness of producers and academics to engage in the actual process of evaluation, and we hope to involve both groups more fully in 1975. The evaluation studies are due just as much to the efforts of students and the academic and production staff, as to ourselves. At the same time, just as the producer has to take the final responsibility for a programme, so we must take final responsibility for these evaluation reports. They do represent in the main our own views, and we must take responsibility for any errors or offence caused by the report.

THE TELEVISION PROGRAMME IN CONTEXT

The Course

Television programme 6, "Fourier Analysis and Transducer Response", is part of the T291 course, "Instrumentation." This is a second-level, half-credit Technology course of 16 units, with 11 television programmes and eight radio programmes. The introductory handbook to the course states that the overall aim of the course is to explain the functioning and operation of instrumentation systems and their component parts. When students have completed the course, they should:

1. have clear ideas about what instrumentation does and the types of application for which it is used;
2. appreciate the problems which arise in employing instrumentation systems, both with the components themselves and the systems as a whole;
3. be aware of some important techniques used for measuring a number of physical variables selected by the course team;
4. be able to choose wisely between two alternative suggested implementations of an instrumentation requirement.

The course assumes no previous knowledge of electronics. The major areas covered by the course are:

1. What is meant by "instrumentation" in this course.
2. The function of an instrumentation system.
3. The role of a transducer in an instrumentation system and how some common transducers work.
4. The concept of signal transmission and transmission path, with examples of these concepts.
5. Examples of signal processing.
6. How signals may be obscured by noise and how signals can be recovered from noise in some cases.
7. Methods of recording and displaying data, illustrated by examples.

The Units.

The programme is associated with the fourth block, covering Units 8, 9 and 10, entitled: "Transducers 2: Acceleration, Vibration, Velocity, Flow." The block is mainly about transducers used for the measurement of motion: motion of solids, liquids and gases. The correspondence text states that the block has three main aims:

1. to introduce the student to acceleration, vibration, velocity and flow transducers and to the principles on which their operation is based

2. to study second-order linear systems, involving ideas of systems, linearity, frequency spectra, and Fourier analysis
3. to introduce the student to the properties of fluid flow, on which depends the operation of flow transducers.

The television programme

The introductory handbook to the course states three aims for television on the course:

1. to illustrate applications of instrumentation in ways that the written word and stationary picture can never do because the situation is essentially dynamic, or on so large a scale that the impressions of size, and difficulty of the environment, can only be gained by "going there" through the lens of the television camera
2. to explain some of the more difficult concepts of the course, those which are essentially dynamic, or three-dimensional, where television is the only way the course team can hope to help the student understand
3. to show the student instrumentation hardware and how it is used, to fill the gap created by the impossibility of providing students with the sort of home kit which the course team would ideally like to send students.

The aims of television programme 6 were not specifically stated to the student, but were given to us by the producer and agreed by the academic responsible for the programme as:

1. to make students aware of the need to know the exact response of each transducer used in a complex system when readings have to be taken together
2. to aid students' understanding of Fourier analysis and synthesis
3. to teach students how to plot the frequency response of an accelerometer.

These three aims overlap with some of the objectives of the correspondence text, particularly with those concerned with Section 6 of Part 1, roughly corresponding to Unit 8.

The programme has quite a complex structure. It consists primarily of three separate content components, roughly equivalent to the three aims for the programme. It is necessary to explain this structure, because it has implications for some of the later results. Table 3 indicates the presenters, the content and the equipment or visual material displayed.

TABLE 3. Structure of Television Programme 6

"Fourier Analysis and Transducer Response"

PRESENTER	CONTENT	TIME	EQUIPMENT/VISUALS
Gaby Smol	The programme opens with film of two examples of pneumatic actuators.	30"	Film
	Gaby Smol then introduces the programme, explaining the need to measure how friction varies during the stroke, and that an experiment will be shown to see how this can be done, and how Fourier analysis can help. He points out that Fourier ideas involve sinusoidal responses, and so the programme will look at sinusoidal response in a couple of transducers.	30"	Smol in studio
	Gaby Smol then demonstrates how an actuator works, and the need for designers to measure the seal friction in actuators.	36"	Caption Graphic
	Film of an experimental situation at Bath University to measure seal friction in actuators is then shown.	1'3"	Film
	This is followed by a diagram showing the placing of transducers to measure acceleration and air-pressure in the Bath University experiment.	49"	Caption Graphic
	It is then pointed out with the help of a graph of the measurements of seal friction in an actuator, that the accurate measurement of friction depends on all transducers measuring at the same point in time. The response of the transducers must be adequate, and this can be discovered by looking at the specification of the transducers. These can be given in terms of sinusoidal response. Sinusoidal response can be interpreted in terms of Fourier analysis PART 1	1'38" 5'6"	Smol with graphic on magnetic board in studio.
John Sparkes	John Sparkes then demonstrates how a wave-form synthesiser works, with the help of a graphic.	7"	Sparkes with Wave-form synthesiser and oscilloscope in studio.
	The synthesiser consists of a number of signal generators, each of which is a sine-wave generator. The outputs from these signal generators are added together and displayed on the oscilloscope. The example given is of a fundamental sine-wave plus harmonics up to the seventh.	37"	Caption Graphic
	Adding together the first, third, fifth and seventh harmonic, the wave-form synthesiser produces a square wave. Sparkes points out that if a transducer could deal with a frequency only up to the seventh harmonic of the fundamental, in response to a square-wave	1'18"	John Sparkes with Wave-form synthesiser and oscilloscope in studio

TABLE 3 (Cont.)

PRESENTER	CONTENT	TIME	EQUIPMENT/VISUALS
	measured : then that is the sort of output one would get. Fourier synthesis reveals that kind of property.		
David Crecraft	To show how sine-waves can be built up, a mechanical model of a sine-wave generator using a wheel, a pulley, string and moving paper, and a mechanical model of a wave-form synthesiser, using a combination of wheels and pulleys, are demonstrated.	3'31"	David Crecraft with two large mechanical models in studio.
John Sparkes	Sparkes then points out that it is necessary to analyse a complex wave such as a square wave.	21"	Sparkes with wave-form synthesiser and oscilloscope in studio.
	Using a caption graphic, Sparkes demonstrates how a spectrum analyser breaks down a complex wave into its component parts.	43"	Caption-Graphic
	This is then demonstrated using the spectrum analyser and the oscilloscope, showing on the oscilloscope plots of the amplitude of component sine-waves against the frequency. Sparkes points out that a spectrum analyser does not indicate the effect of phase, though. Using the synthesiser and oscilloscope, he demonstrates how phase shift of one harmonic grossly distorts the square wave, without this being registered by the spectrum analyser	2'28"	Sparkes, with synthesiser and oscilloscope in studio.
David Crecraft	Using the mechanical model, and by shifting the phase of one wheel (3rd harmonic) by 80°, the same distortion is shown	1'23"	Crecraft with mechanical model in studio.
John Sparkes	If there is a linear phase response, i.e. the phase shift is proportional to the frequencies of the various si -waves, the output of a transducer is nevertheless manageable. Using the synthesiser and oscilloscope, Sparkes demonstrates that linear phase response produces a faithful but delayed response. This applies to all complex waves, not just square waves. Delayed or linear phase shift is important when considering two transducers together, as in the actuator example. The point is made that it would be very unwise to have one transducer with linear phase shift and another with zero phase shift, since substraction would be difficult to measure accurately.	1'55"	Sparkes, with synthesiser and oscilloscope in studio.
	PART 2	12' 24"	
Gaby Smol	Equipment which can measure phase and amplitude of the response of accelerometers is introduced. Two accelerometers, one damped, one undamped are mounted on a table. The equipment is described in the programme as follows: "(The accelerometers) are mounted on a shaker table - which is rather like a large moving coil loudspeaker - driven by a sinusoidal current so that the accelerometers are given a sinusoidal acceleration. They are	1'18"	Smol with shaker table, two accelerometers and oscilloscope in studio.

TABLE 3 (Cont.)

PRESENTER	CONTENT	TIME	EQUIPMENT/VISUALS
	given this acceleration by a swept oscillator. This oscillator produces a current which can be swept in frequency so that the frequency of the applied accelerations can be increased gradually. The output of the accelerometer is taken to (an) oscilloscope". There follows a description of the accelerometers, with the help of a demonstration and a graphic.		
	The motion of the spring of the accelerometers is detected by strain gauges and fed to an oscilloscope to give the acceleration. This enables the phase response of the accelerometers to be measured.	22"	Caption
Gaby Smol (cont.)	Equipment is operated, with the undamped accelerometer, and the reading on the oscilloscope is observed, and then repeated with the damped accelerometer. With the undamped accelerometer, the amplitude increased suddenly and dramatically at the natural frequency of 250, while with the undamped accelerometer, the response is substantially flat over a wider range of frequencies. Thus, if concerned purely with amplitude response - e.g. for friction measurements - it is pointed out that one would choose a damped accelerometer. For phase response, the apparatus also has a phase detector. The apparatus is switched over to phase response, so instead of displaying amplitude, the phase difference between applied acceleration and the output of the accelerometer is displayed. The effect of this on the undamped accelerometer is displayed on the oscilloscope. There is no phase change up to its natural frequency, where the phase response suddenly jumps. The trace is left on the oscilloscope, then the operation is repeated for the damped accelerometer. There is a linear variation of phase with frequency, and phase change at the natural frequency has about half the value for the undamped case. It is pointed out that this would be acceptable in an application where a time-lag was unimportant - but not in friction measurement. In such a situation, one would either have to use an undamped accelerometer, and use it below the natural frequency so as to get the amplitude response level, or use a damped accelerometer below its natural frequency to get negligible phase shift. Natural frequency and damping are what control the sinusoidal amplitude and phase response of accelerometers. Students are informed that details are given in the unit. Finally, it is pointed out that for linear transducers which behave like second order systems, their response can be forecast from knowledge of the natural frequency, and whether they are adequate can be forecast from knowledge of Fourier spectrum of quantity they are trying to measure.	4'50"	Smol with shaker table, oscillator, two accelerometers and oscilloscope in studio.
	PART 3: Time:	6'30"	

It can be seen from Table 3 that the programme uses a wide variety of techniques: film, "talking head", magnetic board, mechanical models of an electronic process, demonstration of equipment, and measurements observed on the oscilloscope. The following equipment and instruments were demonstrated or shown in the programme:

pneumatic actuators
transducers
accelerometers
wave-form synthesiser and spectrum analyser
oscilloscope
shaker-table
oscillator
damped and undamped accelerometer

In addition, three separate presenters were used, each being identified with a clear topic area.

As well as the three aims specified by the producer and academic, it can be seen from Table 3 that the programme was also covering some of the general aims for the use of television in the course. Thus the programme included applications of instrumentation, explanations of some of the more difficult concepts of the course, where the situation is essentially dynamic, and also demonstrations of instrumentation hardware and how it is used. A feature of the programme was the specially constructed models, designed to show mechanically how complex waves are built up from the component sign-waves.

The Broadcast Notes and Supplementary Material

The broadcast notes are given in full below:

T291 Instrumentation

Television Programme 6

First transmission: 06.40 Monday 27 May 1974
Second transmission: 19.05 Friday 31 May 1974
Title: Fourier Analysis and Transducer Response
Speakers: Gaby Smol
David Crecraft
John Sparkes

Remember to fill in Q. Y4 of your CMA T291 45 form after watching this programme.

An experiment to measure the friction of a piston seal provides examples of practical requirements on the response of transducers to time-varying inputs.

A transducer's response to complex time-varying inputs can be evaluated in terms of its response to sinusoidal inputs. This can be done using Fourier analysis and synthesis. The analysis and synthesis of an easily recognized wave-form - a square wave - are demonstrated in the programme.

The sinusoidal responses of two transducers, which can be modelled as second-order systems having different damping factors, are displayed on an oscilloscope. The transducers, a couple of accelerometers, are mounted on a mechanical shaker table. An automatic sweeper is used to vary the frequency of vibration, and plots of amplitude and phase response against frequency are obtained.

The course team were well aware of the brevity of the broadcast notes, but fuller notes were not prepared because the main topics dealt with in the programme were treated in more detail in the first part of the correspondence text, which the student was supposed to study before seeing the programme. Nevertheless, broadcast notes for other programmes were much more extensive.

The tutor-marked assignment, one of four counting towards continuous assessment, contained two questions. Television programme 6 was directly relevant to the first question which carried 40 per cent of the assignment marks, although the question could be answered by reference to the correspondence text, as well. The question was worded as follows:

> The clarity and conciseness with which you present your material will be taken into account when assessing this assignment.
>
> Question 1
>
> (Carries 40 per cent of the assignment marks)
>
> 'If the behaviour of a transducer can be modelled by a linear system, the response of the transducer to any time-varying input can, in principle, be evaluated using the techniques of Fourier analysis and synthesis.'
>
> Justify the above statement:
>
> (a) by explaining what is meant by Fourier analysis and synthesis;
> (b) by describing the relevant properties of linear systems;
> (c) by explaining how these properties can be used, in conjunction with Fourier analysis and synthesis and with the known sinusoidal (frequency) response of the transducer, in order to evaluate its response to a time-varying input having a known frequency spectrum.

In addition, CMA T291 45, one of seven computer-marked assignments counting towards continuous assessment included one question (carrying though less than 5% of the marks) which drew on material covered in the broadcast.

The Timing of the programme.

A feature of the T291 course is the course calendar, which, using colour coding, clearly indicates key dates for students, and also allows space for additional information to be added. The calendar sets out the planned mailing dates of units, the transmission dates for television and radio programmes, and the due and cut-off dates for TMAs and CMAs. (This was one of the most useful and clear calendars we have come across, and a copy is included in Appendix A). However, units 8, 9 and 10 did not go according to plan in 1974. It will be remembered that 1974 began with Britain's worst industrial conflict since the Great Strike of 1926, culminating in the three-day working week. One of the effects of this was to delay the printing of Block 4. Instead of being received by May 18th.

just over a week before the first transmission of television programme 6, the units were not mailed until June 19th. The planned and actual dates are set out in Table 4.

TABLE 4. Planned and actual dates for Block 4 (Units 8, 9 and 10)

	DATE	PLANNED	ACTUAL
MAY	Saturday 11th	TMA02(Units 3 and 4) cut-off	as planned
	Monday 13th	CMA43(Units 5 and 6) due	
	THURSDAY 16TH 7.10pm	RADIO 4 (UNITS 8,9,10-INTRO)	
	SATURDAY 18TH 7.00am	RADIO 4 (REPEAT)	
		RECEIPT OF BLOCK 4	NO BLOCK 4
		BEGIN WORK ON UNIT 8	
	Monday 20th	CMA44 (Units 5,6,7) due date	as planned
	MONDAY 27TH 6.40am	TELEVISION 6 (UNIT 8)	
	THURSDAY 31ST 7.05pm	TELEVISION 6 (REPEAT)	
JUNE	MONDAY 3RD	BEGIN WORK ON UNIT 9	NO BLOCK 4
	Saturday 8th	CMA43 (Units 5 and 6) cut-off	
	THURSDAY 13TH 7.10pm	RADIO 5 (UNITS 8 and 9)	as planned
	SATURDAY 15TH 7.00am	RADIO 5 (REPEAT)	
	Saturday 15th	CMA44 (Units 5,6,7) cut-off	
	MONDAY 17TH 6.40am	TELEVISION 7 (UNITS 8,9,10)	
		BEGIN WORK ON UNIT 10	NO BLOCK 4
	Wednesday 19th	-	BLOCK 4 MAILED
	FRIDAY 21ST 7.05pm	TELEVISION 7 (REPEAT)	
JULY	MONDAY 1ST	CMA45 (UNITS 8,9,10) DUE DATE	BLOCK 4 ARRIVES
	Monday 1st	Begin work on Unit 11	
	MONDAY 8TH	TMA03 (UNITS 8,9,10) DUE DATE	
	Monday 15th	Begin work on Unit 12	
	Monday 22nd	Television 8 (Unit 11)	
	Thursday 25th	Radio 6 (Unit 11)	as planned
	Friday 26th	Television 8 (repeat)	
	SATURDAY 27TH	CMA45 (UNITS 8,9,10) CUT-OFF	
	Saturday 27th	Radio 6 (Repeat)	
	Monday 29th	Begin work on Unit 13	
AUGUST	SATURDAY 3RD	TMA03 (UNITS 8,9,10) CUT-OFF	

It can be seen that the dates had been very carefully planned to ensure that students working on schedule would complete work in Units 5, 6 and 7, and still have a week to study Unit 8 before the first transmission of the Television Programme 6. However, it can also be seen that Units 8, 9 and 10 did not in fact arrive until six weeks after the planned date. Fortunately, since the cut-off dates (the last dates for accepting assignments) for CMA45 and TMA03 - the assignments associated with this block, - were not until 27th July and 3rd August respectively, most students were still able to complete their studies of Block 4 in time to complete their assignments. Even so, the mailing delay was very unfortunate since Television Programme 6 had been planned on the assumption that students would have studied Unit 8 before watching. Although the programme was not transmitted under the conditions planned by the course team, this is not an infrequent occurence in courses in their first year of presentation (see Bates, 1973, and Evaluation

Report No. 2). Therefore, one of the aims of this particular evaluation is to examine just how much information students were able to gain from the television programme alone, even though it was not made with that intention. This is important because even when mailings are on schedule, there is strong evidence from other studies to suggest that many students will not have studied the relevant units before the transmission of a programme (see Evaluation Report No. 1).

EVALUATION OF THE TELEVISION PROGRAMME

METHOD

The programme was discussed with the producer and the course team chairman. As well as discovering how much students were able to pick up from the programme without having read the unit, there was a number of other questions of interest to the producer and course-team chairmen.

1. One problem was that some students were likely to have studied Fourier analysis on other courses, particularly TS282, and T100, whereas others would be meeting it for the first time, since the course assumed no previous knowledge of electronics. Would the programme help those without previous experience of Fourier analysis and still prove of value to those who were familiar with it?

2. A second area of interest was the mechanical model used for simulating the combination of sign waves to form a complex wave. Fourier synthesis is not normally taught this way, and at least one of the presenters was uneasy about using a mechanical model. Would it cause misconceptions in students, or emphasise irrelevant aspects of the machinery, rather than illustrate the principle itself?

3. Another problem was not knowing what students following the course were wanting from television programmes. The course team had decided to use television to a considerable extent to demonstrate practical applications of instrumentation in industry. Perhaps students would have preferred the programmes to concentrate instead on the more difficult points in the correspondence text. (This of course is a matter of principle of wider significance than just the T291 course.)

4. The first of the two transmissions of each television programmes on this course was at 6.40a.m. in the morning. Similarly, the repeat of the radio programme was at 7.00a.m. on a Saturday morning. The University is keenly interested in the problem of early morning transmissions, and so another area of interest was the extent to which T291 students would use such early morning slots.

5. Finally, the evaluators were concerned to discover how students made use of the television programme, <u>why</u> they found the programme useful, difficult, enjoyable or the converse, whether they understood the purpose of the programme, and whether these factors influenced how much students learned from the programme.

On the basis of these questions, a postal questionnaire was designed, (Appendix B). This questionnaire included three content questions. The wording of these questions was drawn up in consultation with the producer, two of the presenters, and the educational technologist on the course team (R. McCormick). Normally, test-type questions are not asked on broadcast

evaluations, since if the questions cover important aspects of the unit, they can usually be answered from a study of the correspondence text. This would have been true in this case, but it was known that the delay in mailing the correspondence texts would be such that the texts would not be available until most of the questionnaires were returned. The three questions set were:

(a) In the measurement of friction in TV6, why is it necessary to consider the possibility of lags between the transducer outputs?

(b) How does Fourier analysis help the engineer (or experimenter) to overcome the problem of lag in such a situation?

(c) Draw a simple block diagram showing the components of the system used in comparing the response of damped and undamped accelerometers (demonstrated towards the end of the programme). This should include an indication of how the applied acceleration amplitude was kept constant.

Students were asked to spend no more than 20 minutes on these three questions, and to answer briefly and in note form. In the covering letter, they were told that the questionnaire would not be used for student assessment purposes.

From the 1011 students registered for T291 at that time, a random sample of 268 students (27%) was drawn. The questionnaires were mailed to students on Monday, 3rd June, during the week following the transmission of the television programme. After two reminders to non-respondents, 181 usable questionnaires were returned, a response rate of 68%. The sampling error is $\pm$ 5%. All the open-ended answers to each question are presented, uncoded, in Appendix C.

A day-school for T291 students had been arranged for Saturday, June 15th, in London, 12 days after the repeat transmission. With the co-operation of Owen Laurence, the staff tutor, the programme was shown on video-tape to one of the seminar groups, and then discussed afterwards. There were thirteen students in the group, plus the producer, one of the presenters, the staff tutor, and the evaluator. The discussion was sound-recorded, and the full transcript is presented in Appendix D.

The part-time tutors on this course were also involved in the CT4 scheme. This meant that there were course tutor reports on Television Programme 6 sent in to the University, and this information has also been used. (Appendix E).

Finally, Blocks Y and Z of CMA T291 45 were used as part of the course team's standard feedback procedure. This included a question on Television Programme 6. (Appendix F).

These sources of information can be summarised as follows:

TABLE 5. Sources of Information on Television Programme 6.

No. of students registered at time of programme: 1011

	No. sampled	No. of respondents	% response
Postal questionnaires	268	181	68%
Group discussion	-	13	-
Part-time tutors (CT4)	45	20	44%
OMA 45	1011	437	43%

RESULTS

Viewing and Listening Figures

On the postal questionnaire, information was requested not only about when or if students viewed Television Programme 6, but also about the first three radio programmes and the first four television programmes (the fifth was left out of the questionnaire by error). The results of these questions are given in Tables 6 and 8.

TABLE 6: Student Viewing Figures: Programmes 1-6

(TX = transmission)

	Total		No. and % viewing at least one TX		1st TX Monday 6.40am ONLY		2nd TX Friday 7.05pm ONLY		Both TX		Neither TX	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
TV 1	181	100	155	86	52	29	82	45	20	11	26	14
TV 2	181	100	152	84	47	26	83	46	21	12	29	16
TV3	181	100	148	82	41	23	96	53	10	6	33	18
TV 4	181	100	132	73	38	21	73	40	20	11	49	27
TV 6	181	100	90	50	9	5	68	38	12	7	91	50

Notes:
1. To find % of students viewing at 6.40a.m., add to 6.40 a.m. figures % for viewing both transmissions. e.g. TV1 = 29% + 11% = 40%
2. One student saw all programmes 1-4 but could not remember which transmission.
3. Another student saw TV 6, but only on video-tape.

Almost exactly half the students who responded to the questionnaire watched Television Programme 6. This is at first sight a surprisingly low figure, compared with the viewing figures for programmes 1 to 4, which

averaged over 70%. However, the first transmission of Television Programme 6 was at 6.40 a.m. on 27th May, 1974, which happened to be a bank holiday (Whit Monday.) Similarly, Table 7 below shows that almost 10% of the students were away from home on holiday that week.

TABLE 7: Reasons for missing Television Programme 6.

Code No. (Appendix C)	Reasons given for not watching	No. of students who did not view	% of 181 respondents
3/6/9	Work reasons	18	10
1	Away on holiday	15	8
2	Forgot/no particular reason.	14	8
5	Other commitments	12	7
7	Transmission times not suitable	10	6
4	Away overseas	6	3
8	New baby/illness/ hospital	3	2
13	Too much study/too little time	3	2
10/11/12/14	Other reasons	7	4
16	No answer	6	3
	All responding students	94	53

(some students gave more than one reason)

These results indicate the comparative value of early morning broadcasts. Although the Monday morning transmission was used by only a minority of students (between 30% - 40% for programmes 1-4), nevertheless the transmissions helped considerably in ensuring high viewing figures overall for the course, up to the time of enquiry. No Friday evening figure exceeded two-thirds of the registered students, and when some students, not surprisingly, showed a reluctance to get up for 6.30 in the morning on a Bank Holiday, this had a marked effect on the overall figure, since the numbers watching the Friday evening transmission on 31st May hardly dropped at all. Five students taped the sound of Television Programme 6.

TABLE 8: Student listening figures: Programmes 1-3

(TX = transmission)

	Total		No. and % listening to at least one TX		1st TX Thursday 7.10pm ONLY		2nd TX Saturday 7.00am ONLY		Both TX		Neither TX	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Radio 1	181	100	110	61	86	48	20	11	4	2	71	39
Radio 2	181	100	101	56	82	45	17	9	2	1	80	44
Radio 3	181	100	84	46	64	35	17	9	3	2	97	54

The radio figures began reasonably well (61%) but by programme 3 had dropped to 46%. Few students (less than 15%) listened on Saturdays at 7.00a.m. These figures are disappointing, since this course uses a form of radio-vision, combining the radio programmes with detailed broadcast notes, through which the student is led during the course of the broadcast. Perhaps even more disappointing though was that over a quarter of the students had not listened to any of the first three radio programmes. Once again though in these evaluation studies, there are marked individual differences, since another quarter of the students had not missed a single programme, television or radio. Indeed, 69% of the students had seen at least four out of the five television programmes about which they were asked. A very small number of students (13) neither watched nor listened to any programmes, and of these, four were overseas or lived outside BBC 2 and VHF transmission areas, and the rest found the times of the programmes too inconvenient. So, although there is a large group who do not listen to radio programmes regularly, this does not apply for the television programmes on this course. (Table 9)

TABLE 9: No. of students who have watched and listened to various numbers of programmes.

Table 9(a) Television	All respondents		Watched TV 6		Did not Watch TV 6	
	No.	%	No.	%	No.	%
All 5 TV programmes so far	69	38	69	77	0	0
4 out of 5 TV programmes	56	31	20	22	36	40
3 out of 5 TV programmes	29	16	1	1	28	31
2 out of 5 TV programmes	9	5	0	0	9	10
1 out of 5 TV programmes	4	2	0	0	4	4
None out of 5 TV programmes	14	8	0	0	14	15
	181	100	90	100	91	100

TABLE 9 (Cont.)	All respondents		Watched TV 6		Did not Watch TV 6	
9(b) Radio	No.	%	No.	%	No.	%
All 3 radio programmes	69	38	51	57	18	20
2 out of 3 radio programmes	25	14	12	13	13	14
1 out of 3 radio programmes	37	20	16	18	21	23
None out of 3 radio programmes	50	28	11	12	39	43
	181	100	90	100	91	100
All TV and radio programmes	45	25	45	50	0	0
No TV or radio programmes	13	7	0	0	13	0

There is one further point to be made regarding the viewing and listening figures. Table 10 shows a considerable discrepancy for Television Programme 6 between the figures from the postal questionnaire, and figures from CMA feedback.

TABLE 10: Comparison between broadcast questionnaire and CMA feedback

Programme	Broadcast questionnaire				CMA Feedback		
	No. sent out	No. returned	Response rate(%)	Viewing/ listening figures(%)	No. of students registered at time of CMA cut-off date	Response rate (%)	Viewing/ listening Figures(%)
TV 1	268	181	68	86	1017	80	85
TV 2	268	181	68	84	1017	78	83
TV 3	268	181	68	82	1017	71	83
TV 4	268	181	68	73	1011	75	76
TV 5	No.inf.	No.inf.	No. inf.	No. inf.	999	70	75
TV 6	268	181	68	50	985	46	66
Radio 1	268	181	68	61	1017	76	67
Radio 2	268	181	68	56	1017	73	63
Radio 3	268	181	68	46	No. inf.	No.inf.	No.inf.

These discrepencies are important, because a number of course teams base maintenance and remake decisions on CMA feedback. Although the base for CMA returns is all registered students, the actual response rate, after the first couple of months of a course, based on questions about television and radio that are actually answered, tend to be lower than for the specially designed questionnaires for broadcast evaluation. There is evidence from other studies that, irrespective of the source of information (CMAs, course unit report forms, special postal questionnaires), the lower the response rate, the greater the bias in respondents towards students who view and listen (see Bates, 1973, and Broadcast Evaluation Reports Nos. 2 and 4). There is also evidence that non-viewers are more likely to drop out than viewers

(Broadcast Evaluation Report No. 4). This reinforces the view that it is better to have a high response rate based on a small representative sample than to rely on large numbers of returns, if these returns nevertheless constitute a lower response rate. The lower the response rate, the greater the likely overestimate of viewing and listening figures. For this reason, although the number of CMA returns for Television Programme 6 is greater than the number of postal questionnaire returns for Television Programme 6, we place greater reliance in the questionnaire returns. Indeed, we would guess that even the viewing figure of 50% is an overestimate for the total number of students registered at the time of the programme (but nevertheless is not likely to be less than 45%). Consequently, the CMA figure of 66% is very likely to be misleading, and certainly as a course progresses and the number of CMA returns decrease, CMA figures are likely to give increasingly large overestimates of the proportion viewing and listening.

Student reactions to TV 6.

In analysing student reaction to the programme, we have examined not only the quantitative information from the pre-coded answers, but also the qualitative information from the open-ended answers. It is important that the answers to questions on usefulness, enjoyment, difficulty, purpose, and the test-type questions are taken as a whole.

If this is done, it is quite clear that the programme was positively received by about 70% of the students who watched, while conversely about 30% reacted negatively to the programme.

TABLE 11: Student reactions to Television Programme 6.

		No. of students	% of viewers
USEFULNESS	Very useful	19	21%
	Fairly useful	44	49%
	Not very useful	24	27%
	Not at all useful	1	1%
	Don't know	2	2%
	All students who watched	90	100%
ENJOYMENT	Very enjoyable	12	13%
	Quite enjoyable	34	38%
	All right	36	40%
	Not very enjoyable	6	7%
	Not at all enjoyable	1	1%
	Don't know	1	1%
	All students who watched	90	100%
DIFFICULTY	Very difficult	3	3%
	Fairly difficult	20	22%
	Just right	39	43%
	Fairly easy	17	19%
	Very easy	8	9%
	Don't know	3	3%
	All students who watched	90	100%

Those who reacted negatively can be broken down further into three roughly equal groups: those who totally failed to see the purpose of the programme, or wanted to suspend judgement until they had seen the text; those who thought the programme was of little value, because they had already studied Fourier analysis and synthesis, and claimed therefore to have learned nothing new from the programme; and finally those who realised that the programme was concerned with the application of Fourier analysis to the problems of measurement caused by time-lag in transducers, but did not feel that the programme had succeeded in this aim.

This latter point reflects that behind the positive reaction of 70% of the students, there lie some doubts about the success of the programme in achieving its objectives, and therefore it is important to examine the information on student reactions very carefully. Few students found the programme unenjoyable (7 out of 90). In particular, the mechanical model was specifically mentioned in favourable terms by nearly half the viewers (44%). Furthermore, only a quarter rated the programme fairly or very difficult. This figure is surprising, for a number of reasons. The programme was made on the assumption that students would have already studied the relevant part of the text, while we know that this was not possible. It is even more surprising in the light of the poor results of most students on questions set on the content of the programme.

TABLE 12 - Answers to Content Questions

Question	GRADE								
	All students who watched	A Satisfactory answer		B Part of answer		C Relevant, but no explanation		D No answer, wrong, irrelevant	
	No.	No.	%	No.	%	No.	%	No.	%
9a) In the measurement of friction in TV6 why is it necessary to consider the possibility of lags between transducer outputs?	90	27	30	9	10	17	19	37	41
9b) How does Fourier analysis help the engineer to overcome the problem of lag in such a situation?	90	16	18	13	14	10	11	51	57
9c) Draw a simple block diagram showing the components of the system used in comparing the response of damped and undamped accelerometers (demonstrated towards the end of the programme). This should include an indication of how the applied acceleration amplitude was dept constant.	90	19	21	7	8	3	3	61	68

Now some of the weaknesses of performance-type tests have already been outlined earlier (pp.4 and 20-21). Despite consulting the producer, the central academic, and the educational technologist, two of the questions were unsatisfactory. Dr. Smol thought that 9b was too difficult to answer from the programme alone, and the last part of 9c ("This should ..... kept constant") referred to a part of the programme which was removed in the final video editing. In addition, there is evidence that some students did not give these questions the same kind of attention that they would have done if their answers had counted towards their assessment. Finally, some students already had sufficient prior knowledge to answer the questions without having to see the programme. (One student actually described equipment which one might have been expected to use, rather than the very latest equipment that was actually shown!) Even allowing for these weaknesses, though, on none of the questions did more than 40% of the students provide, at a minimum, even part of the answer.

The discrepency between the students' subjective and largely favourable reaction to the programme, and their actual difficulty in recalling the major content of the programme, can perhaps be explained by their view of what the programme was about (see Table 13). For most students who viewed (82%), the clearest and most valuable part of the programme was the explanation of the synthesis and analysis of complex wave forms. However, the application of Fourier analysis to instrumentation problems, and in particular to the problems caused by phase-shift and time-lag, was far less frequently mentioned (37%). For instance, while about three-quarters of the viewers mentioned specifically the explanation of Fourier analysis and synthesis, spectrum analysis, or the effects of adding harmonics to the fundamental wave, as being one of the main purposes of the programme, only a quarter specifically mentioned phase-shift or the problems of time-lag. (In addition, another fifth - 23% - were unable to offer any suggestion as to the purpose of the programme.)

TABLE 13: Identification of value and purpose of programme

	Any mention		Purpose of programme	
	No.	% of viewers	No.	% of viewers
Fourier analysis/synthesis/ complex wave, etc.	74	82	66	73
Mechanical model, visual aids.	40	44	3	3
Time-lag, phase-shift.	33	37	25	28
Damped/undamped accelerometers.	5	6	2	2
Actuators/friction/stiction.	2	2	2	2
Didn't know purpose, no answer.	Not applicable		21	23

Despite so few students mentioning phase-shift and time-lag, nevertheless, just as many students (about a dozen) mentioned that they did not understand the application of Fourier analysis to the problem of time-lag or phase-shift in transducers as students who had doubts about whether they really understood Fourier analysis.

It seems clear therefore that the students enjoyed the programme and found it useful because of the novel way it dealt with Fourier synthesis and analysis. Since 61% of the students already had some previous knowledge of Fourier analysis, and an even higher proportion - 83% - had work experience as an electrical or mechanical engineer, it appears that this enabled them to enjoy the programme, despite not having studied the unit. Furthermore, just over half the actual programme was devoted to an explanation of Fourier synthesis and analysis, and spectrum analysis, which together with student familiarity with the former might explain why the application of Fourier analysis, and the problems caused by phase-shift and time-lag, failed to register with most students.

The Broadcast Notes.

The broadcast notes suffered from printing difficulties to some extent in the same way as the correspondence text. Those responsible for the programme were aware that the notes were inadequate, but an effort was nevertheless made to get the brief notes that had been prepared to students in time, by means of a special mailing. Even this proved difficult. Over 20% of the students who viewed reported that they had not received the notes at the time of returning the questionnaire, which in most cases was at least a week after the repeat transmission. It is likely though that some students were anticipating fuller notes, and therefore were unaware that they had actually received all the notes they were going to get. Whatever the reason, a third of the students had not read the notes by the time they completed the questionnaire. Not surprisingly, of the 56 students who had read the notes, two-thirds found them insufficient. It is interesting nevertheless to examine the reasons given for students finding the notes insufficient, as it gives a chance to see what students are looking for in broadcast notes.

The most common request (14 students) was for more diagrams and photographs of the equipment and the oscilloscope traces, primarily to act as reminders, for revision purposes. A smaller number of students (seven) specifically asked for more detail of the academic content of the programme - the relevant theory, the main principles - to be summarised in the notes. Four students wanted the notes to follow up the programme in some way, for instance by giving more information about the final demonstration, or by explaining "how Fourier synthesis can be used to model mechanical system response." It must be remembered though that at this stage the students had not received the correspondence text, and some of these points should have become clearer after studying the texts.

Reaction to Television on the Course as a Whole

The great majority of students (84%) found television of at least some value on the course. Of those who could watch and also answered the question (173), only 21 - or less than 1 in 8 - answered "not of much value" or "no value at all." No outstanding reason emerged for these students finding television of little or no value, although 17 students in all mentioned the inconvenience of the transmission times, and about 10

mentioned that there was not enough theoretical or intellectually demanding material in the programmes.

Students were asked to state a preference for the kind of programme they would like. The answers are given in Table 15.

TABLE 14: Kind of television programme policy preferred by T291 students.

Policy	No. of students	%
A. Concentrate almost entirely on extending or reinforcing the basic theoretical concepts in the correspondence texts, through demonstrations and illustrated lectures.	43	24
B. Mostly as (A), but also spend at least some time demonstrating the practical application of the basic concepts in the correspondence texts, by filming and discussing industrial and research application.	129	71
C. Use in some other way	7	4
No answer	2	1
All responding students	181	100

The majority of students on T291 appear to be clearly in support of the general policy for television laid down by the course team. Most students evidently, despite the pressures of studying part-time, are still interested in the applications of the concepts they learn in the correspondence texts.

Finally, in order to discover whether there were special factors about the course, such as overloading or excess difficulty, which might have influenced unduly students' reaction to Television Programme 6, two general questions were asked about the course as a whole. A lot of students gave detailed comments, and our interpretation of the main points made is summarised as follows:

1. Most students appeared to be finding the course interesting, but somewhat difficult, particularly the emphasis on electronics for those with little previous knowledge of electricity.

2. Some students were also finding the course a little disjointed. No doubt the unavoidable delays in receiving texts was not helping to keep the course together, but a number of students commented that the course was not so coherent as TS282, and several students also commented that they were glad they had studied TS282 first, because of the help it gave them with T291.

3. The main criticisms however - strongly supported by the tutors,

incidently - appeared to be of the first set of TMAs and CMAs. A number of students and tutors expressed the opinion that these either did not test sufficiently students' understanding of the basic principles covered in the course, or assumed knowledge which the student could not have derived from the course itself.

4. There were a number of comments on the poor quality of the binding and paper used in the correspondence texts, resulting in the texts disintegrating after a little use, in contrast to texts on other OU courses.

In general, however, most students who returned the questionnaire seemed to be enjoying the course and consequently there appear to be no special factors other than the delay in receiving the units which are likely to influence unduly students' reactions to Television Programme 6. (The summary above however does not do justice to the wealth of comments on the course supplied by students, and the T291 maintenance course team in particular might find it valuable to read through the full comments from questions 14 and 15 in Appendix C)

DISCUSSION

There is a number of interesting issues arising from these results and from our description of the television programme in the context of the course as a whole. The discussion of these issues that follows inevitably reflects a more personal view and is offered more tentatively than the previous sections of this report, but nevertheless it might be valuable in stimulating thought about the more general issues arising from the study.

First of all, let us look at where the course team's policy regarding television, and the programme itself, has been clearly successful. Certainly, the programme covered ground which would have been extremely difficult to cover in any other way in the Open University system. Besides the wide range of equipment and its operation demonstrated in the programme which would be clearly impossible to provide through home experiment kits, an abstract concept (Fourier analysis and synthesis) was successfully demonstrated by using ingenious mechanical models. Indeed, because of the large numbers of students who are likely to follow the course (probably 5,000 to 6,000 over the life of the course), the high cost of constructing such a model is probably amply justified, and resulted in the teaching of the concepts in a way that is beyond even a conventional university. Furthermore, there is no doubt from the results that most students, despite having some previous acquaintance with Fourier analysis, found this aspect of the programme very clear and helpful. In addition, the policy of mixing the extension or reinforcement of basic concepts with demonstrations of the application of these concepts in industry and research was widely supported by most students on the course. Finally, the programme was well-integrated with the rest of the unit, and indeed, course tutors reported that students did in fact draw on the programme for their TMA answers.

Nevertheless, despite these clear successes, there are serious doubts

about some aspects of the programme. There was clearly an educational intent behind the programme, but equally clearly there was a mismatch between what the course team saw as being the main aim of the programme, and what the majority of students perceived to be the main aim. The students clearly recalled the demonstration of Fourier synthesis and analysis, but most were unable to follow the relationship between this and the problems caused by phase-shift and time-lag in transducers, which appeared to be the main aim of the programme, from the course team's point of view. It does appear that ironically, the failure of most students to understand the demonstration of phase-shift and resonance in damped and undamped accelerometers can be partly attributed to the use of the mechanical models for demonstrating Fourier analysis and synthesis. An examination of the content of the programme (Table 3, pp. 12-15) shows that over half the programme was devoted to the explanation of Fourier analysis, synthesis and spectrum analysis, and the demonstration of the electronic and mechanical models, while the main conceptual ideas regarding the measurement of phase and amplitude in damped and undamped accelerometers were crammed into the last six and a half minutes. The striking visual impact of the models, and the time needed to demonstrate them, the previous acquaintance of many students with Fourier analysis, the lack of clear and detailed notes to direct students clearly to the main aim of the programmes, and the delay in students receiving the texts, all combined to place greater emphasis on the explanation of Fourier analysis than on the newer and more difficult aspects of measuring phase-shift and amplitude in transducer response systems. On the other hand, the model clearly made a concept with which many students were already familiar much clearer. The lesson perhaps is that care must be taken to ensure that such powerful visual techniques are used, but kept under very tight control, in terms of the time devoted to their demonstration. Thus in this particular programme, it appears that less time spent on the models, and more time on the latter part of the programme, was needed, and that broadcast notes showing the aims of the programme, the link between Fourier analysis and the problems of measuring phase-shift and amplitude in transducer response systems, and diagrams of equipment and the main traces are also necessary, even though this is partly covered in the correspondence text. (This is because it is optimistic to assume that most students will be on schedule with their reading of the texts when the broadcast is transmitted - see below).

It may also be worth making one further point on Fourier analysis. This has been the subject of television programmes on T100, TS282, M201 and SM351, at least. Although different aspects of the subject have been dealt with, it is obviously a subject which not only lends itself to television, but which is of key importance in Mathematics and Technology. There might be a case for this being included within the remade Technology and/or Mathematics foundation courses. Also, the Open University library has now nearly completed its cataloguing of television programmes. With increasing costs and the pressure on transmission time, it would be sensible to make use of this cataloguing system to avoid duplication, at least in production,

of such key areas as Fourier analysis.

The study also throws interesting light on the problem of scheduling and transmission times. The course was very carefully designed so that for students working on schedule, the programmes would be transmitted to fit in with their studies. Thus one week was given for study of the relevant correspondence text before the transmission of the programme, if the student had completed work on the previous block by completing TMA 02 and CMA 43 and 44 by the due dates. However, even if the texts had been mailed in time, previous studies (e.g. Evaluation Reports 1 and 2) show that it is overoptimistic to expect students to be on schedule, as measured by the due dates. Most students work to cut-off dates, particularly when studying more than one course at a time. In is unrealistic therefore to expect most students to have read the relevant text before seeing a programme, if the planning is such that there is only one week between receipt of the text and transmission of the programme, particularly if the course is a half-credit, or if the cut-off date for the TMA is $2\frac{1}{2}$ months away, or if the cut-off date for assignments for previous units comes later than the transmission of the programme.

There are a number of ways around the problem. The simplest is to move the cut-off dates nearer to the time students are meant to finish their work on a particular block. Alternatively, some of the relevant parts of the text could be summarised or condensed in the broadcast notes (although if they are too long, students are not likely to read these either.) Another solution may be to make a variety of programmes, some introductory or self-sufficient, others relying on the previous study of the correspondence texts, but transmitted later in the course. Each course-team will have to decide its strategy according to the shape of a course as a whole. Nevertheless, if students are to obtain maximum benefit from the broadcasts, planning must be such that there is a much more realistic appreciation of the way students study in the Open University than has occurred on many courses to date.

Finally, there is the question of early-morning transmission times. Somewhat to our surprise, there is a substantial minority of T291 students willing to use the 6.40a.m. transmission slot on a Monday, sufficient to ensure respectable overall viewing figures, even though quite a lot of students categorically refuse to watch at that time. More critical perhaps is that the early morning transmission is the first, with the repeat at 7.05 p.m. on a Friday. With an evening transmission as the repeat, there is obviously a temptation to avoid the early morning transmission. If something unexpected occurs, however, and the evening transmission is missed, there is then no opportunity to catch the repeat. It would seem preferable therefore to allocate the evening slot for the first transmission, and the early morning slot for the repeat. Also, the course team appears to be unfortunate in receiving a Monday morning/Friday evening combination, which for some students is an awkward arrangement. It would be better if future allocations to courses avoided this combination, if at all possible.

SUMMARY AND RECOMMENDATIONS

SUMMARY

1. The programme, from the point of view of the course team, had a very clear educational intent, in terms of demonstrating both concepts, and equipment and its use. However, while most students clearly recognised the aim of explaining the basic principles underlying Fourier synthesis and analysis, few students recognised and understood the relationship between Fourier analysis and the problems caused by phase-shift and time-lag in transducers. This was due to a number of reasons: delay in mailing units to students, which meant that students could not study the relevant text before watching the programme, as planned; the extent of time within the programme devoted to the explanation of Fourier synthesis and analysis, and the consequent condensing of the section explaining the measurement of frequency response in damped and undamped accelerometers; and the fact that most students were already somewhat familiar with Fourier analysis and synthesis.

2. The programme used television appropriately in the Open University context. It showed application of basic instrumentation principles in industry and research; presented dynamically a difficult concept by means of modelling and of demonstrating relevant oscilloscope tracings; and also demonstrated the actual use of large and expensive instrumentation equipment.

3. The programme was well-integrated with the text, demonstrating and developing concepts covered in the text, and indeed providing material which students were able to draw on in their tutor-marked assignments.

4. About half the students on T291 watched the programme. This figure was probably lower than for most other programmes on this course, since it was transmitted over a bank-holiday period. This affected particularly the first transmission which was on Whit Monday at 6.40a.m.

5. The early morning transmission slot, although of no use for many students, nevertheless helped to keep viewing figures high as a whole.

6. Listening figures began at just over 60% for the first radio programme, but had dropped to about 45% for Radio 3.

7. Most students (over two-thirds) were regular viewers of T291, with a quarter having watched and listened to every programme by the half-way stage of the course. Conversely, another 25% had seen or heard no programmes at all on T291.

8. Most students who watched reacted favourably to the programme, whether or not they had previous acquaintance with Fourier analysis and synthesis.

9. The mechanical models used to demonstrate Fourier synthesis were very much appreciated by students, enabling them to understand much more clearly the basic principles of Fourier synthesis and analysis. On the other hand, over half the programme was devoted to this aspect, partly because of the time spent on explaining and demonstrating the models, and this

resulted in the latter part of the programme, concerned with the measurement of frequency response in damped and undamped accelerometers, being extremely condensed.

10. The general policy adopted by the course of using television at least partly for demonstrating the practical applications, in industry and research, of the basic concepts contained in the correspondence texts was supported by the majority of T291 students.

11. The broadcast notes were inadequate (see recommendation below).

12. The study emphasised the need to ensure high response rates for obtaining reliable information on viewing and listening figures, low response rates giving large overestimates of actual viewing and listening figures. It also demonstrated that students' subjective reactions to the usefulness, enjoyment and difficulty in a programme do not provide a reliable guide to the amount of value actually gained from a programme, in terms of understanding the content and the aims of a programme. The study also emphasised the difficulty in an evaluation study of setting good performance-type questions on broadcasts even when the broadcast has not been reinforced by a correspondence text. Therefore there is a need to use multiple sources of information to build up a reliable picture.

13. The overall picture that emerges of T291 Television Programme 6 is that it formed a very useful component of the unit and block to which it was related, but that its full potential was not realised, partly due to circumstances outside the control of the course team (the industrial problems caused by the three-day week), but also partly due to weaknesses in course and programme design.

RECOMMENDATIONS

The general aim of the evaluation exercise is to produce knowledge about broadcasts which will help decision-making in courses other than the one on which the study has been carried out, since the opportunity for remaking programmes is limited financially, and is often influenced by factors other than the value of the programme itself (such as, for example, a decision to replace the correspondence text to which a programme is related). However, in this particular instance, there is a strong possibility of remaking Television Programme 6 on T29'. (The decision to do this though is not directly related to the evaluation.) Therefore these recommendations are both more detailed than on other of the evaluation studies, and are intended more as a basis for course-team discussion than as unchallangeable recommendations for action.

1. Because of the strong possibility that large numbers of students will not have read the relevant correspondence text before the television transmissions, the T291 maintenance team may wish to re-examine the course calendar, to see whether Television Programme 6 - or any other programme which assumes prior study of the texts - could be transmitted more than one

week later than the start-date for Units 8, 9 and 10. The maintenance team may also like to re-examine the desirability of cut-off dates for TMAs and CMAs falling so late after students are supposed to have watched programmes, given the way students tend to "bunch" their studying in the period immediately preceding cut-off dates. Alternatively, the course-team may prefer to remake Television Programme 6 as an introductory programme to Fourier analysis and synthesis, possibly incorporating not only the present section on Fourier analysis and synthesis, but also parts of other OU programmes on the same subject, if these are relevant.

2. Two of the recommendations made regarding transmission times have already been taken into account in the 1975 schedules. The Monday morning/ Friday evening combination has been avoided, and the early morning transmission is now the repeat. (The new television times are: Sunday, 9.20a.m. - first transmission; 7.05a.m. Monday - second transmission.)

3. If the maintenance team wish the programme to continue to examine the problems caused by lags in transducers, and the problem of measuring frequency response in damped and undamped accelerometers, then more time should be spent on explaining the measurement of frequency response in damped and undamped accelerometers, and the links with Fourier analysis and the problem of lag,probably at the expense of time spent on explaining Fourier analysis and synthesis - particularly regarding the demonstration of the models. The film of experiments at Bath University might also be removed, since it may be possible to explain the problems caused by lag without the film. In any case, the broadcast notes should contain much of the explanation of the equipment used to demonstrate frequency response in accelerometers, rather than to use the sound commentary to do this, as is done at present, and this may save further time for a clearer explanation at the end of the programme of the links between Fourier analysis, frequency response in accelerometers, and the problems caused by lag.

4. As well as including descriptions of the equipment as outlined in (3) above, the broadcast notes should include:

(a) a clear statement of the objectives of the programme, especially the intention to relate Fourier analysis to problems of lag (if this is the case)

(b) diagrams and photographs of all the equipment demonstrated

(c) diagrams of the relevant oscilloscope traces.

5. Finally, this may be a point which has arisen due to a lack of expertise in instrumentation by the evaluators, but it is also a point raised by several students. The programme begins with a problem - the effect of lag when comparing transducer responses. Does the measurement of the frequency response of damped and undamped accelerometers actually solve the problem? It appears from the analysis of the programme that thisproblem is not actually resolved during the programme. If this is the case, the students need to be

told this fact, and the subsequent relevance of Fourier analysis and the measurement of the frequency response of accelerometers needs to be carefully explained, if necessary by cross-referencing to the correspondence text.

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